

## **SECTION 31 40 00**

### **SHORING AND UNDERPINNING**

#### **PART 1 - GENERAL**

##### **1.01 SECTION INCLUDES**

- A. Detection of movement
- B. Shoring and underpinning
- C. Concrete piers, walls, and pile caps
- D. Piles and caissons
- E. Load testing of piles and acceptance criteria
- F. Fill and backfill
- G. Temporary supports
- H. Restoration

##### **1.02 RELATED SECTIONS**

- A. Coordinate the work of this Section with the work of Section 31 23 19 - Dewatering, and Section 31 50 00 - Excavation Support and Protection.

##### **1.03 MEASUREMENT AND PAYMENT**

- A. Measurement: Shoring and Underpinning will be measured for payment by the lump-sum method, acceptably constructed and completed.
- B. Payment: Shoring and Underpinning will be paid for at the indicated Contract lump-sum price, as indicated in the Bid Schedule of the Bid Form.

##### **1.04 REFERENCES**

- A. State of California, Department of Transportation (Caltrans), Office of Structure Construction, "Trenching and Shoring Manual."

##### **1.05 DEFINITIONS**

- A. Shoring: Props or posts of timber or other material in compression or bending, used for temporary support of excavations, formwork, or unsafe structures.
- B. Sheet piling: A line of timber or planks, plain or tongue-and-grooved on sides, driven endwise into the ground to protect subgrade operations.

- C. Underpinning: Permanent construction, as indicated, which directly transmits existing structure foundation loads to a lower bearing elevation or strata, and which preserves the structures being underpinned.
- D. Support: Facilities required to prevent movement of existing structures until the completion of the underpinning.
- E. Lagging: A temporary or permanent excavation support structure consisting of heavy timber boards, planking, or sheathing secured in place by steel H-piles.
- F. Restoration: Reconstruction by repair or replacement of portions of structures removed or altered by underpinning and support operations.
- G. Parcel: An area as indicated, including the structures thereon, and any vaults and permanent closure walls connected thereto.

#### **1.06 SUBMITTALS**

- A. Requirements: Refer to Section 01 33 00 - Submittals, and Section 01 33 23 - Shop Drawings, Product Data and Samples, for submittal requirements and procedures. Shop Drawings and supporting calculations for shoring and underpinning shall be submitted to the Engineer for review and approval.
- B. Excavating, Shoring, and Underpinning Program: Prepare and submit a written schedule and procedure, along with detailed drawings, of the proposed excavations, shoring, and underpinning work to the Engineer for review.
- C. Shop Drawings: Submit Shop Drawings, indicating method, staging, and necessary details for construction of underpinning and support for each structure on which work is to be performed. Show details of shop assemblies when required for restoration of structures. Shop Drawings and calculations shall be prepared, sealed, and signed by a professional civil or structural engineer currently registered in the State of California.
- D. Calculations: Submit design analyses and calculations to support Shop Drawings.
- E. Procedures:
  - 1. Submit procedure for detection of movement, as specified in Article 3.01 herein.
  - 2. Submit procedure for preloading (jacking load) new foundations.
  - 3. Submit procedure for proof load testing and preloading (jacking load) of lateral support systems, such as strut and tieback assemblies.
- F. Jacking Gage Calibration: Submit data for the pressure gage and jack combinations certified by an accepted testing laboratory not earlier than 14 days prior to start of use for underpinning.
- G. Restoration: Submit procedures, methods, and materials lists for restoration of structures and facilities.

**1.07 REGULATORY REQUIREMENTS**

- A. Regulatory requirements that govern the work of this Section include the following governing codes:
1. California Code of Regulations, Title 8, Chapter 4, Subchapter 4 — Construction Safety Orders, and Subchapter 19 — Trench Construction Safety Orders.
  2. California Code of Regulations, Title 24, Part 2, California Building Code, Chapter 33 and Appendix Chapter 33, and Structural Chapters 18 and 18A.
    - a. Excavations shall be defined or classified as being in excess of 12 feet in depth below grade, and, as such, shall comply fully with the requirements of Sections 3301.2, 3301.2a, and 3301.03 of the California Building Code.
    - b. Contrary to certain provisions of the California Building Code, Sections 3301.2 and 3301.2a, extensions of foundations, if any, regardless of depth, shall be at the expense of the Contractor, and the Contractor shall make provisions for such expense.

**1.08 SITE CONDITIONS**

- A. Access: Parcels will be available as indicated in the Contract Specifications. Notify the Engineer at least 30 days in advance of the date on which the Contractor requires occupancy of parcels to be underpinned, supported, and restored.
- B. Staging and Working Space: Working areas for underpinning and support are shown on the Contract Drawings. If additional working areas beyond those obtained by the District are necessary, obtain use of such areas at no additional expense to the District.
- C. Permits: The District will obtain and pay for permits for entry into structures and for the right to perform underpinning, support, and restoration as indicated. The Contractor shall obtain and pay for all other permits, give all notices required, and make all other arrangements necessary.
- D. Temporary Partitions: Where indicated or required, build closed temporary partitions of suitable materials to isolate the work site from the portions of the structure not occupied by the Contractor.
- E. Maintenance of Services: Locate, protect, support, and maintain uninterrupted all utilities, equipment, services, and owner's and tenant's chattels within the limits of the underpinning work, or relocate same as indicated or required.

**PART 2 - PRODUCTS****2.01 MATERIALS AND EQUIPMENT**

- A. Requirements: The Contractor shall furnish all materials, tools, equipment, facilities, and services as required for providing the necessary shoring and underpinning work and facilities. Jacks and jacking equipment shall be more than adequate for the imposed loads and shall be provided with calibrated gages.

- B. Shoring and Bracing Materials: Provide heavy timber posts, beams, planks, boards, pipe struts, pin piles, and accessories as required.
- C. Lagging and Sheeting Material: Provide heavy timber boards, planking, or sheathing as required. Lagging boards shall be secured in place by steel H-piles, with boards inserted between the H-flanges.
- D. Piles and Caissons: Refer to Sections 31 62 00 - Driven Piles, and 31 63 29 - Drilled Concrete Piers and Shafts, for requirements. Provide piles and caissons as indicated.
  - 1. Underpinning Pier: As defined, an excavated pit, provided generally by manual excavation, which is carried to a pre-selected bearing surface and then filled with concrete to provide supplementary foundation support for the underpinned structure.
- E. Concrete: Refer to Sections 03 11 00 - Concrete Forming, 03 20 00 - Concrete Reinforcement, 03 30 00 - Cast-In-Place Concrete, and 03 05 15 - Portland Cement Concrete, for requirements. Concrete shall be regular concrete weighing not less than 145 pounds per cubic foot, with a minimum compressive strength at 28 days of 4,000 psi.
- F. Shotcrete: Refer to Section 03 37 13 - Shotcrete, for requirements.
- G. Grout: Refer to Section 03 61 11 - Non-Shrink Grout, for requirements.
- H. Structural Steel: Refer to Sections 05 12 00 - Structural Steel Framing, and 05 50 00 - Metal Fabrications, for requirements.

### **PART 3 - EXECUTION**

#### **3.01 DETECTION OF MOVEMENT**

- A. For each existing structure that may be affected by the work, install settlement markers on each footing, building corners, wall or surrounding improvements to be monitored. Settlement markers shall be capable of being read to an accuracy of 0.005 foot.
- B. Take and record readings not less than once per week during performance of the work until the permanent structures is complete to the ground level.
- C. Stop work; notify the Engineer, and take immediate remedial action if movement of the existing structure occurs during performance of the work.
- D. Upon completion of the work, take weekly readings of the measurement points for a period of 4 weeks, or longer if movement persists, and report the results to the Engineer.
- E. The detection of movement shall be performed by a qualified licensed land surveyor or civil engineer.

**3.02 SHORING AND UNDERPINNING**

- A. Existing footings, foundations, pile caps, grade beams, retaining walls, or pavement which may be affected by excavation operations shall be shored or underpinned adequately or otherwise protected against settlement and shall be protected against lateral movement.
- B. Provide soldier piling, lagging and sheeting, tie-backs, slurry diaphragm wall, and cementitious grouting, as required, to hold back earth at excavations and as required to prevent cave-ins and earth sloughs.
- C. Footings, foundations, pile caps, grade beams, retaining walls, or pavements which have been undermined by earthwork and pile-driving operations shall be filled and supported with concrete extended to undisturbed bearing earth or bedrock.
- D. Concrete may be placed as a stiff mix of minimum slump (dry pack), or concrete may be pneumatically placed (shotcrete), or concrete may be placed by conventional methods with concrete formed to hold it in proper position.

**3.03 CONCRETE PIERS, WALLS, AND PILE CAPS**

- A. Install concrete underpinning piers, walls, and pile caps as indicated, with the bottom at the indicated or bearing elevation and the top approximately three inches below the structure to be underpinned. Dry pack the space within three days after concrete placement is completed.
- B. Where earth forms are indicated, install waterproof building paper or board between the earth and concrete to prevent water loss from the fresh concrete.
- C. Do not remove support of existing structure until concrete piers, walls, or pile caps have attained design strength.

**3.04 PILES AND CAISSONS**

- A. Install pipe pile shells or drilled shafts at locations indicated, and extend from underside of existing footings to indicated elevations, plus additional penetration if required to develop the design working load of the pile or caisson. Drilled shafts shall conform with requirements of Section 31 63 29 - Drilled Concrete Piers and Shafts
- B. Distribute jacking reactions over the existing structure in a manner that will not overstress or deflect the existing structure.
- C. Weld splices where indicated. Provide watertight welds capable of developing the full strength of the pile or caisson. Align splices to ensure the straightness of the pile from top to tip. Use outside sleeves and backup rings as necessary.
- D. Where the pile tip is below the ground-water table, maintain the elevation of the water inside the shell at approximately the elevation of the ground-water table during installation of the shell.
- E. After installation of the shell, apply the full design-working load to the empty pile shell and maintain until there is no measurable settlement over a one hour period.

- F. Maintain the excavation within the pile shell approximately 12 inches above the tip during driving, and dewater pile shells prior to filling with concrete in a manner which will prevent loss of earth or soil at the tip. An earth plug may be left in the pile tip or a concrete plug may be placed and cured prior to dewatering pile shells.
- G. After load testing to the design load, dewatering, and inspection of the shell by the Engineer, fill accepted pile shells with concrete in the presence of the Engineer. Keep an accurate record of the volume of concrete deposited in each pile. Deficiencies revealed by comparing the volume of the inside of the pile with the volume of placed concrete will be cause for rejection of the pile or correction of the deficiency.
- H. Securely wedge in place with steel wedges those piles that have satisfied the load-testing requirements. Weld and encase in concrete all wedges, plates, wedging struts, and piles, as indicated or required.
- I. Following completion of load transfer of underpinned structures, fill the underpinning pits with concrete as indicated. Provide reinforcement, shear keys, dowels, and waterstops as indicated or required. Place concrete to within 3 inches of the underside of the existing foundation. After three days, dry pack the space between the foundation and concrete.

### **3.05 LOAD TESTING OF PILES AND ACCEPTANCE CRITERIA**

- A. After the concrete within the pile or shaft has set for at least 24 hours, test each pile or pier by jacking to a load equal to 150 percent of the design-working load of the pile. Maintain the load until there is no measurable settlement of the pile over a one-hour period.
- B. Load-test piles in sequences and groupings that will minimize or eliminate eccentric loadings on the existing foundation and piles.
- C. Piles will be rejected and shall be retested if, in the opinion of the Engineer, there is a danger of unequal loading.
- D. Should the existing structure fail to furnish sufficient reaction to installed underpinning piles to the test loads specified, provide additional reaction to prevent damage to, and movement of, the structure during installation of piles, and to obtain specified underpinning test loads. The additional reaction shall not detrimentally affect the structure.
- E. Maximum out-of-plumb tolerance for installed piles: two percent.
- F. Maximum offset of top of pile from the design center: 3 inches.

### **3.06 FILL AND BACKFILL**

- A. Provide engineered fill and backfill in accordance with applicable requirements of Section 31 00 00 - Earthwork, after acceptance of the underpinning by the Engineer.

### **3.07 TEMPORARY SUPPORTS**

- A. Install temporary supports where necessary to support structures to be underpinned and those that will be affected by underpinning and restoration work.

**3.08 RESTORATION**

- A. Restore existing structures to conditions equivalent to those existing prior to the start of shoring and underpinning work, including repair of any settlement-related damage.

**END OF SECTION 31 40 00**